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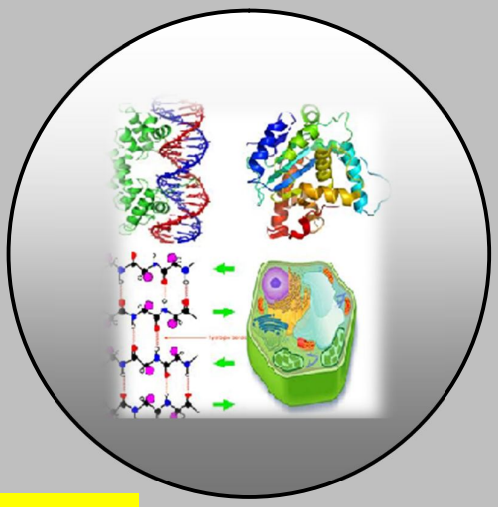

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Relationship between Foot Length, Foot Breadth, Ball Girth, Height and Weight of School Children Aged 3-5 Years Old

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ABSTRACT

Anthropometry, as an early tool of physical anthropology; has been used for identification, for the purpose of understanding human physical variation, in paleo anthropology and in various attempts to correlate physical with racial and psychological traits.

This study is an attempt to estimate the relationship between foot length, foot breadth, ball girth, height, and weight of school children aged 3-5 years old; to know the extent of the development and factors that influence their development and how these parameters can be used in anthropometric studies. Two hundred children of both sexes were sampled using simple random sampling technique. The parameters were measured using a height scale, marker pen, ruler, electronic bathroom scale.

Pearson coefficient showed the relationship between the various parameters measured, multiple comparisons was also used to find the mean difference between the age groups, ANOVA was used to determine the mean for the parameters variation by age, t-test was used for sex difference.

In all these correlations used, all the parameters; except ball girth showed significant relationship in both genders, but with higher values in the males than the females.

In conclusion, foot length, foot breadth, and ball girth can be regarded as three separate elements, which are to be precisely known for optimal manufacturing of shoe lasts. While height and weight are useful in the estimation of developmental status in children; and the data collected has added literature to anthropometry in children.

Key words: Foot Length, Foot Breadth, Ball Girth, Height, Weight and Paleo anthropology.

INTRODUCTION

Over the decade, anthropometry was regarded as an early tool of physical anthropology; it has been used for identification, for the purposes of understanding human physical variation, in paleo anthropology and in various attempts to correct physical with racial and psychological traits Wikipedia (2009). Today, anthropometry plays an important role in industrial design, clothing design, ergonomics and architecture where statistical data about the distribution of body dimensions in the population are used to optimize products. Changes in life styles, nutrition and ethnic composition of populations lead to changes in the distribution of body dimensions, for example obesity, require regular updating of anthropometric data collections Wikipedia (2009).

In human population, average height for each sex varies significantly, with males being taller than females. Females ordinarily reach their greatest height at a younger age than the males. Vertical growth stops when the long bones stop lengthening which occurs with the closure of epiphyseal plates Wikipedia (2011). The human foot is a very complicated part of the body and the feet of young children are soft and pliable, so abnormal pressures can easily cause the foot to deform. The foot of a child grows rapidly during the first year, reaching almost half their adult size. That first year can be very important in the development of the feet (epodiatry.com, 2004).

The stature of a human being depends on a number of factors that are affected by genes and environment. According to most studies, a big factor that determines human height is how the person resembles their relatives. On the other hand, there are other analysts who have noted that human height is affected by the different ethnic groups to that people belong.

There are also other studies that showed that the height of human is affected by multiple factors such as environment, dietary habits, ethnicity, lifestyle, and genetic background. A given environment can maximize the potential genetic function of a given population and hence give them a higher heritability for that specific trait (Chao-Qiang, 2006).

Overweight and obesity are well recognised as health problems and have been internationally standardized for children (Cole et al. 2000). Analysis of footprints can reveal very important clues which can be used as forensic evidence, assessment of the rate of growth and development in children and helps in the estimation of stature and body weight of an individual. Previous investigation has found that both overweight and obesity were associated with foot posture in 835 children aged three to six years with flat foot found in 51% overweight children, 62% of obese children, and 42% of children of normal weight (Pfeiffer et al., 2006). A German study used a scanner to investigate the influence of body mass on the development of a child's foot in 1450 boys and 1437 girls aged 2-14 years. This study identified five types of feet**: flat, robust, slender, short and long. Flat and robust feet** were more common in overweight children, whereas underweight children showed more **slender** and **long feet** (Mauch et al. 2008). A similar study involving 7788 children (48% males and 52% females) showed that most static and dynamic foot characteristics change continuously during growth and maturation. Static foot length and width increased with age from 13.1±0.08cm (length) and 5.7±0.4cm (width) in the youngest to 24.4 ± 1.5 cm (length) and 8.9±0.6cm (width) in the oldest (Muller et al. 2011). A study carried out by Samai Mohamed, et al. 2009 in Sierra Leone to determine the relative anthropometric measurements commonly used in nutrition survey; was carried out on 306 pre-school children of both sexes aged 1-5 years. The various anthropometric measurements were assessed through comparison of their mean values and correlation co-efficient. A close relationship was observed between weights, weight-height ratio which was very sensitive in the assessment of nutritional status of the children

Clinicians often disagree about the management of foot deformity (Bresnahan and Evans 2009), partly because there is no standard approach to assessment or classification.

MATERIAL AND METHODS

Ethical approval was obtained from the Human Research and Ethics committee at the University of Jos, Jos, Plateau State, Nigeria. The University of Jos Primary School were approached and consented to use their pupils for this research. Consent forms were returned from the parents of 200 children, aged between three and five years selected by simple random technique. Gender distribution for the study consisted of 98 males and 102 females. Demographic data was collected from the returned consent forms so was inclusion (age) and exclusion (no history of foot surgery or congenital disorders) criteria.

The 200 children were assessed by one examiner using the following materials: Height Scale and Measuring Tape:

- Marker Pen
- Ruler
- Electronic bathroom scale
- Consent Form

The following general body anthropometric measurements for each child were made and recorded by additional research assistant with data recorded to the nearest centimetres and kilogram: foot length, foot breadth, ball girth, height and weight. Foot length was measured using a measuring tape, as the distance between the pternion (the rearest point of the heel) and the tip of the longest toe parallel to the foot axis, foot breadth was measured as a straight distance from the most medially placed point on the head of the 1^{st} metatarsal to the most laterally placed point located on the head of the 5^{th} metatarsal with a measuring tape, ball girth or foot circumference was also measured with a measuring tape(flexible)so that the tape passes over the meta tarsale tibiale and the meta tarsale fibulae, the height was measured as a vertical distance from the vertex to the bottom of the foot(floor).
The subjects were made to stand erect on a horizontal resisting plane barefooted with buttocks touching the wall. Both feet were in close contact with each other and the head oriented in Frankfort's plane and the weight was measured with a scale and recorded in kg. All measures were recorded against each child's allocated identity (ID) code. All measures were performed with children dressed, but with shoes and socks removed.

RESULTS AND DISCUSSION

Results displayed from the table 1, that the age range of the subjects is 3-5 years, while the total number of all male subjects is 98, and that of the females is 102 (49% males, and 51% female) respectively. The recorded assessments yielded both categorical and continuous data. Descriptive statistics (mean, standard deviation, minimum, maximum, frequencies) were used to examine the basic anthropometrical characteristics of the population. Data were entered and all analyses were performed using constructed data sets in Microsoft Excel 2000 (Microsoft Inc, Redmond, Washington) software package.

Table 1. Showing distribution of age, sex and number of subjects.

AGE	NUMBER OF MALES	NUMBER OF FEMALES
3	27	34
4	19	24
5	52	44
TOTAL	**98**	**102**

Table 2. Showing Oneway Anova for parameters variation by age of the subjects.

Descriptive									
						95% Confidence Interval for Mean			
		N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound	Minimum	Maximum
Height	3yrs	61	102.382	4.93124	0.631	101.119	103.6449	93.5	115
	4yrs	43	109.1953	5.6342	0.859	107.4614	110.9293	101	120
	5yrs	96	114.174	5.85862	0.598	112.9869	115.361	102.5	129
	Total	200	109.507	7.5171	0.532	108.4588	110.5552	93.5	129
Weight	3yrs	61	14.3918	1.70688	0.219	13.9547	14.829	10.9	19.3
	4yrs	43	16.6651	2.068	0.315	16.0287	17.3016	12.7	21.8
	5yrs	96	17.849	2.40044	0.245	17.3626	18.3353	13.2	25.4
	Total	200	16.54	2.60313	0.184	16.177	16.903	10.9	25.4
Ball girth	3yrs	61	10.3541	0.64848	0.083	10.188	10.5202	8.9	12
	4yrs	43	10.414	0.69815	0.106	10.1991	10.6288	8.8	12
	5yrs	96	10.4969	0.80203	0.082	10.3344	10.6594	8.9	12.6
	Total	200	10.4355	0.73532	0.052	10.333	10.538	8.8	12.6
Foot length	3yrs	61	16.5885	1.04946	0.134	16.3197	16.8573	14.7	18.4
	4yrs	43	17.8	1.09087	0.166	17.4643	18.1357	15.7	20.3
	5yrs	96	18.3271	1.02076	0.104	18.1203	18.5339	15.9	20.9
	Total	200	17.6835	1.28488	0.091	17.5043	17.8627	14.7	20.9
Foot breadth	3yrs	61	6.8115	0.45244	0.058	6.6956	6.9273	5.7	7.6
	4yrs	43	7.3581	0.47068	0.072	7.2133	7.503	6.5	8.6
	5yrs	96	7.3621	0.44382	0.045	7.2722	7.452	6.4	8.3
	Total	200	7.1933	0.51654	0.037	7.1213	7.2653	5.7	8.6

Note: The mean for the different parameters variation by age was carried out and found to be increasing significantly as the age's increases.

Not many studies have been carried out to determine the relationship between foot length, foot breadth, ball girth, height and weight as a whole in Nigerian children and other parts of the world. However, so many studies are available on the determination or prediction of one or two of these parameters but not a combination of all as has been done in this present study.

From this study, the Mean foot length for the males is 17.85cm and that of the females is 17.53cm which is lower than that of the males and the mean foot breadth was also found to be 7.27cm for the males which is higher than that of the females; 7.12cm. This correlate to (Mukta Rani, 2011) study and (Muller, et. al, 2011) who studied 7788 children (48% males and 52% females) showed that most static and dynamic foot characteristics change continuously during growth and maturation. This indicates that males have longer and broader feet than females.

The reason could be due to Sex difference which when viewed from a biomechanical perspective, suggested that sexual dimorphism in relative foot length which is in the opposite direction, may be partly due to forces of inter sexual selection that favoured a reduction in female foot length over human evolutionary time Fessler et al. 2005. In men, the right foot tends to be larger than the left foot whereas in women, on average, the reverse pattern is observable.

The mean ball girth found for the 3 year old subjects is 10.35cm, and 10.41cm for the 4 years old, for 5 years old 10.50cm;which showed increase with age, but not significant

Mean weight for the 3 years old subjects is 14.39kg, 4 years old as 16.67kg and that of the 5 years old as 17.85kg. This show an increase in weight with advancement in age, the mean weight for the males is 16.61kg and that of the females is 16.47kg; which shows that the value for the males is higher than that of the females. This could be attributed to nutritional and genetic factors. The mean height for all the 3 years old is 102.38cm, 4 years old as 109.20cm, and for the 5 years old as 114.17cm. It was observed that as the children advanced in age so also there is a significant increase in height. This study also established the mean height value for the males as 109.82cm and 109.21cm for the females in this study population (males higher than females). This could be due to multiple factors such as environment, dietary habits, ethnicity, lifestyle, and genetic background. A given environment can maximize the potential genetic function of a given population and hence give them a higher heritability for that specific trait Chao-Qiang, 2006.

From this study, using ANOVA to confirm the difference of the means for parameter variation by age between and within the groups; it was discovered that all the parameters were significant except the ball girth which was not significant. This correlate with Anil et al. 1997, study on the relationship between foot length, foot breadth, ball girth, height and weight of Turkish students aged between 17 and 25 of both sexes. It was found that foot length, foot breadth, ball girth, height and weight of male students in the same foot category were greater than the female students and Sen and Ghosh, 2008, study among Rajbanshi males and females of North Bengal on a sample of 350 adult Rajbanshi and 100 adult Meche individuals aged 18-50 years residing in different villages showed that stature height, weight, foot length, and foot breadth are positively and significantly correlated with each other.

CONCLUSION

From this study, it is observed that the relationship between foot length, foot breadth, ball girth, height, and weight of 200 school children aged 3-5 years old of the university of Jos primary school, had statistical significant relationship of both genders to all the parameters studied except the ball girth which showed no significant relationship.

The males had increased values in all the parameters of study, which can be due to the weak ligamentous structure in the females' feet which results in the collapse of the longitudinal arch during weight bearing as reported by Henning (2001).

It can also be concluded that foot length, foot breadth, and ball girth can be regarded as three separate elements, which are to be precisely known for optimal manufacturing of shoe lasts while height and weight are useful in the estimation of developmental status in children.

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